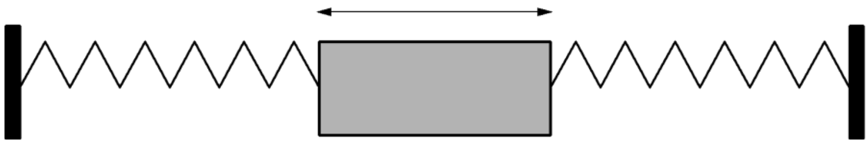
27 A mass M oscillates in simple harmonic motion between two fixed supports. Frictional effects can be ignored. The time period of the oscillation is T_1.



The mass is replaced with a mass of 4 M **and** the amplitude of the oscillation is doubled. The new time period is T_2.

Which is the correct statement?

$T = 2\pi\sqrt{\frac{m}{k}}$

A $T_2 = 4\,T_1$

B $T_2 = 2\,T_1$

C $T_2 = T_1$

D $T_2 = ½\,T_1$

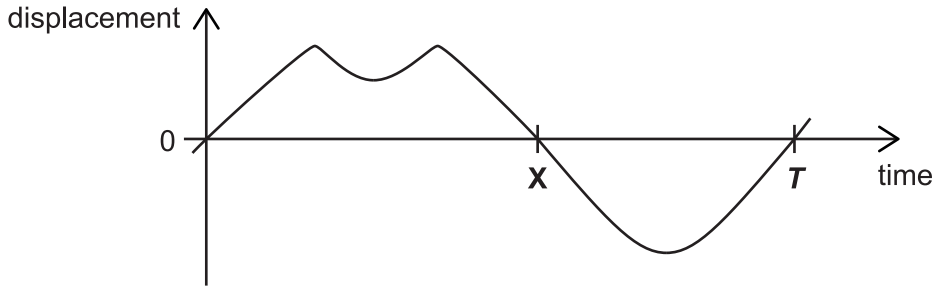
$T \propto \sqrt{4}$

Your answer

[1]

amp makes no difference

9 The graph shows the displacement of a body which is oscillating periodically with time period ***T***.



Which statement is correct?

A The acceleration is zero at time **X**.

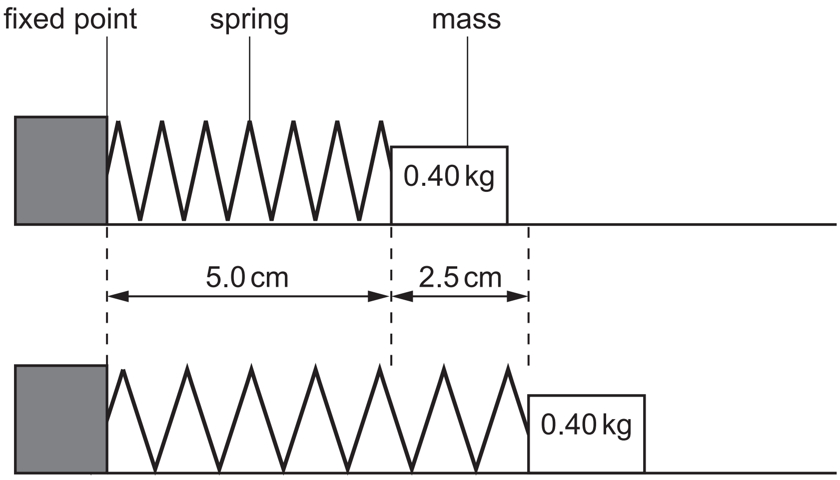
B The body is performing simple harmonic motion.

C In each cycle the velocity is zero three times.

D The body changes direction at **X**.

Your answer [1]

10 The spring in this diagram has a spring constant of $20\,\mathrm{N\,m^{-1}}$.
The mass is pulled away from the fixed point. The spring stretches by 2.5 cm.
The mass is then released.



What is the maximum speed reached by the mass?

A $0.18\,\mathrm{m\,s^{-1}}$

B $0.53\,\mathrm{m\,s^{-1}}$

C $1.25\,\mathrm{m\,s^{-1}}$

D $3.75\,\mathrm{m\,s^{-1}}$

Energy stored $= \frac{1}{2} k x^2$

$= \frac{1}{2} \times 20 \times (2.5 \times 10^{-2})^2$

$\frac{1}{2} m v^2 = 6.25 \times 10^{-3} = 6.25 \times 10^{-3}\,\mathrm{J}$

$\Rightarrow 176 \times 10^{-3}\,\mathrm{m/s}$

Your answer [ ] **[1]**

11 An electron is travelling at a speed of $3.1 \times 10^{5}\,\mathrm{m\,s^{-1}}$.

What is its kinetic energy in electronvolts?

A $4.4 \times 10^{-20}\,\mathrm{eV}$

B $8.8 \times 10^{-7}\,\mathrm{eV}$

C $0.27\,\mathrm{eV}$

D $500\,\mathrm{eV}$

Your answer [ ] **[1]**

38 **Fig. 38.1** shows a displacement *s* against time *t* graph for the motion of a swing in simple harmonic motion.

Fund 2017

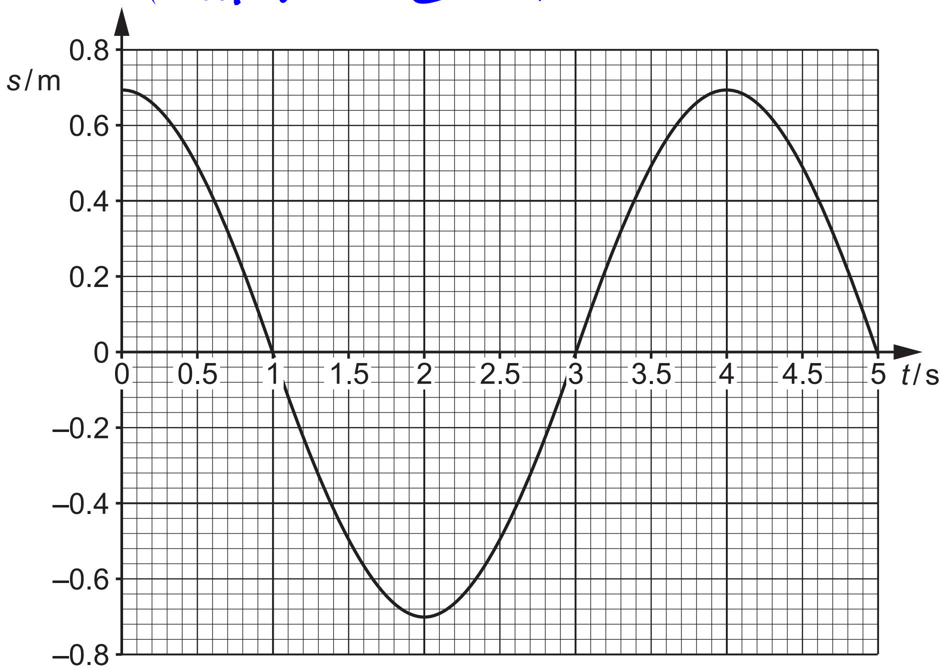


Fig. 38.1

(a) Use **Fig. 38.1** to find the magnitude of the maximum velocity of the swing.
Make your method clear.

steepest grad at t: 3

velocity = ... 1.1 .... $m\,s^{-1}$ **[2]**

(b) On **Fig. 38.2** scale the y-axis suitably and draw the velocity v against time t graph for this motion.

grad of fig 38.1

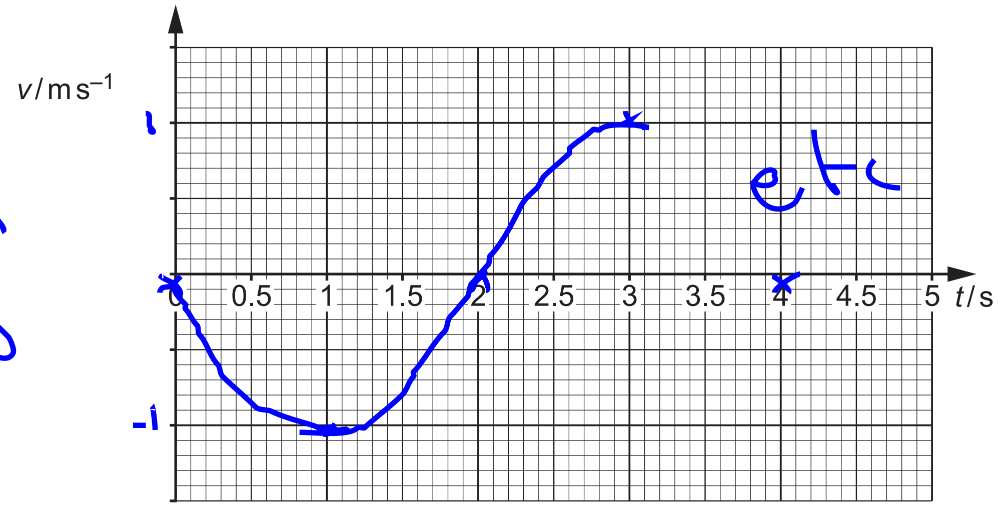


Fig. 38.2

[2]

(c) Show that the length of the simple pendulum having the same time period as the swing in **Fig. 38.1** is less than 4.0 m.

T = 4 sec from graph

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$\left(\frac{4}{2\pi}\right)^2 \times g = l \Rightarrow l = 3.97\,m$$

(3sf)

[2]

2017 prac

2 This question is about the behaviour of a mass on a spring.

(a) The table below shows how the extension *x* of a spring varies as the mass *m* suspended vertically from it alters.

m / g	*x* / cm	
100	2.5	2.5×10^{-2}
200	5.1	2.6×10^{-2}
300	7.5	2.5×10^{-2}
400	9.9	2.5×10^{-2}
500	12.5	2.5×10^{-2}
600	15.0	2.5×10^{-2}

Fig. 2.1

(i) Apply a test to the data to see if the extension of the spring is proportional to the applied force. Explain your method and state your conclusion.

if $x \propto f$ then $\frac{x}{f}$ = const

did to 2sf (though 3 would have been ok)

the value is consistent ∴ $x \propto f$ is true

[3]

(ii) Calculate the spring constant *k* of this spring.
g = 9.8 N kg^{-1}

$\frac{F}{x} = k \Rightarrow \frac{0.3 \times 9.8}{7.5 \times 10^{-2}} =$

k = 39 N m^{-1} **[1]**

(b) In order to investigate the behaviour of an oscillating mass and spring system, the spring is suspended vertically below a vibration generator. A mass is added to the bottom of the spring. The arrangement is suspended above an ultrasound distance sensor as shown in Fig. 2.2.

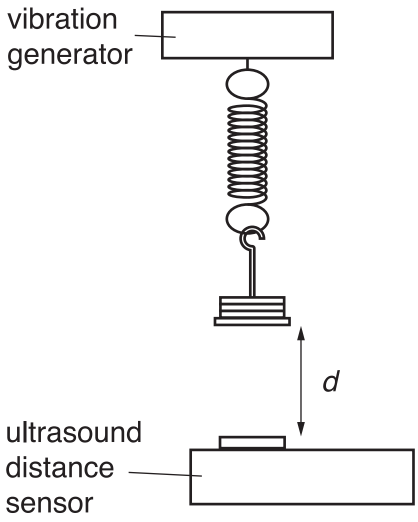


Fig. 2.2

With the vibration generator switched off, the mass is given a small vertical displacement then released. A few oscillations later the ultrasound distance sensor is started and the trace shown in Fig. 2.3 is displayed on a computer.

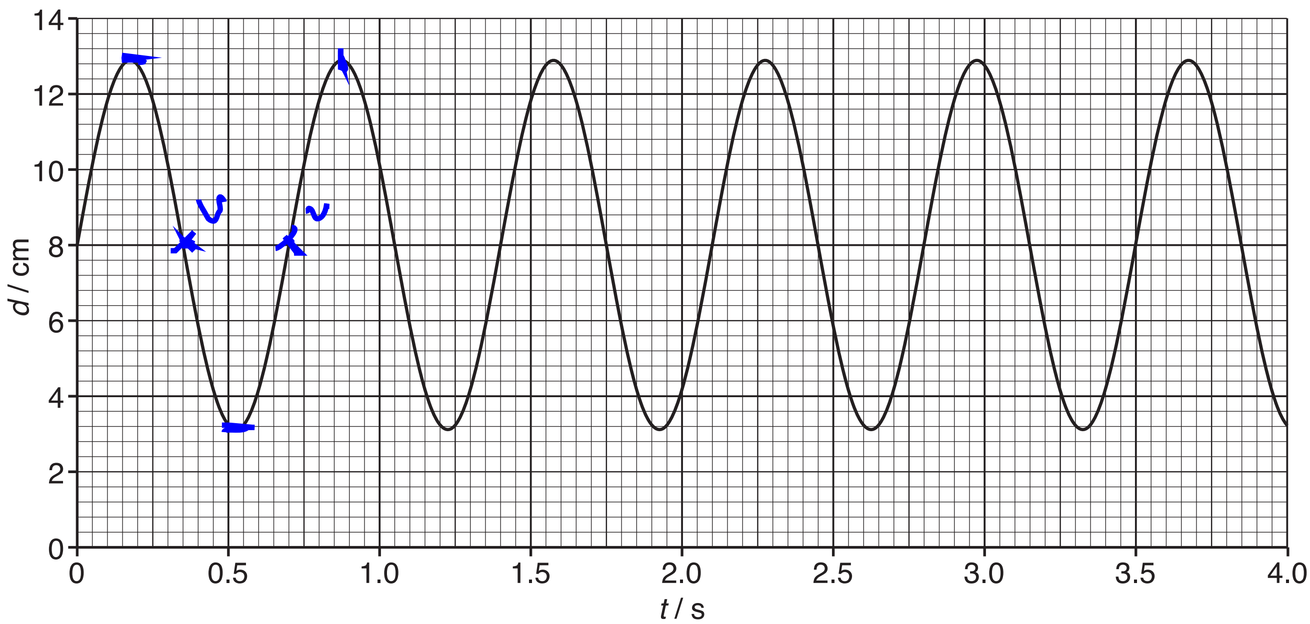


Fig. 2.3

(i) Mark **two** points on the curve shown in Fig. 2.3, to indicate where the speed of the oscillating mass is at its maximum. Label each point with a letter **V**. **[1]**

mid point = 8cm

(ii) Use data from the trace shown in Fig. 2.3 to calculate the natural frequency *f* of the mass and spring system.

P → P =

1.4 Hz

f = ... Hz **[2]**

(iii) Show that the mass *m* supported by the spring is about 500 g.

$T = 2\pi\sqrt{\frac{m}{k}}$

$f = \frac{1}{1.4}$

$\left(\frac{T}{2\pi}\right)^2 k = m = 0.5\ kg$

$= 500g$

[2]

(c)* By connecting the vibration generator to a signal generator it is possible to use this apparatus to investigate forced oscillations of the mass and spring system. Describe in as much detail as possible how you would carry out the investigation, the data that you would record and what you would expect the results to show.

See

marks

scheme

[6]

Question			Answer	Marks	Guidance
3	(a)	(i)	Minimum of three equally spaced horizontal lines between poles. Arrows on lines N to S	1 1	Lines should be perpendicular to magnet surface and start and touch (or finish close to) surface. Accept curved lines to show edge effects. Ignore field lines outside of the magnet assembly.
		(ii)	Interaction between magnetic field of wire and permanent magnetic field gives rise to a (vertical) force on the wire; which produces a (reaction) force on the magnets (hence balance reading changes)	1 1	 Reference to Newton's third law.
	(b)	(i)	Mean change of both balance readings to 2sf Both values of F	1 1	0.37; 0.47 2sf only – stand alone sf penalty 3.6 or 3.7; 4.6 Allow ecf from incorrectly rounded figures for mean change in balance reading. (3.7 and 4.5)
		(ii)	Largest difference between mean value and max (or min) is 0.03g OR largest half range = 0.02g Either: $\Delta F = \Delta m\, g = \pm 0.3 \times 10^{-3}$ N or $\pm 0.2 \times 10^{-3}$ N depending on previous answer. Or: relative uncertainty in balance reading = $\Delta m/m$ for whichever of the bottom two rows used, to give absolute uncertainty in force = $\pm 0.3 \times 10^{-3}$ N or $\pm 0.2 \times 10^{-3}$ N	1 1	Identification of max variation in data. Allow ecf from incorrect value in bottom row of table. Assuming g has zero uncertainty. Accept multiplying raw data in bottom row by g before finding difference in F values. 0.02/0.47 = 4.3%, 0.02/0.37 = 5.4%, 0.03/0.47 = 6.4% Allow ecf from wrong rounding.
		(iii)	Both points correctly plotted (to within ½ small square) LoBF drawn	1 1	(2.5, 3.6) and (3.0, 0.46) or ecf from table. Line must extend across the range of points shown. No more than 2 small squares vertically from any plotted point.
		(iv)	Gradient calculated from points on line B = gradient/L or B = gradient/0.05 or 5) B = 30 mT	1 1 1	Ignore POT Acceptable range of gradient: $1.4\ \text{mNA}^{-1} < m < 1.7\ \text{mNA}^{-1}$ ecf from their LoBF Correct POT in final answer. Accept values within range: 28 mT < B < 34 mT
			Total	**13**	

SECTION B